North Carolina Division of Forest Resources

FORESTRY Leaflets

FM-40 March 2006

Fertilizing Guidelines for Established Loblolly Pine Forest Stands

Forest trees require several soil-based elements to grow and maintain health. These include the "big three" macronutrients, nitrogen, phosphorus, and potassium, as well as several important micronutrients. Many forest soils in North Carolina lack one or more nutrients in quantities sufficient for optimum tree growth.

Adding these deficient nutrients through fertilization increases forest stand value by temporarily increasing tree growth, health and vigor, and wood volume. Loblolly pine stands respond well to fertilization at mid-rotation with increased growth. Landowners can use fertilization to increase financial return.

What the Research Tells Us:

- Poorly drained soils in eastern North Carolina and clay soils in the Piedmont respond well to phosphorus fertilization at establishment.
- Fertilizing stands at mid-rotation (8-20 years) or late-rotation (20-35 years) also produces strong growth response in loblolly pine.
- As trees grow, they demand more soil nutrients. Between ages six and eight (at crown closure), the young loblolly trees often need more nutrients than the soil can supply.
- Adding nitrogen (N), phosphorus (P), and potassium (K) supplements soil deficiencies.
- Fertilizing with N, or N + P, or NPK + boron shortly after crown closure or after thinning increases crown size (number of leaves) and wood production (diameter and height growth).
- Growth responses after fertilization generally last six to eight years
- Growth response to mid-rotation fertilization decreases as the soils' sand or clay content increases.
- Growth response to mid-rotation fertilization decreases as soil drainage decreases. Soils with a gray color or gray spotting at or near the surface are poorly drained.

Make Fertilizers Work for You

Not all forest stands benefit from fertilization. To make fertilization work for you, be sure your stand is 1) responsive to the nutrient amendments, 2) operable in size (greater than 40 acres), and most importantly, 3) nutrient deficient. Tree growth is often limited by soil conditions other than poor nutrition. Be aware that fertilizers do not pay where other factors limit growth (i.e. too little or too much moisture, shallow topsoil). Look at your site carefully to determine if fertilization will pay. Obtain the services of a forester to help you with this determination.

Know Your Soil

- Compacted soils (common in former agriculture fields and pastures) and poorly drained soils have poor soil aeration that limits root growth.
- Shallow soils with heavy clay or rocky subsoil restrict rooting depth.
- Sandy soils are low in organic matter, low soil moisture, have poor cation exchange, and are infertile (deficient in N, P, K and boron).
- Clay soils are easily compacted, have low soil strength, poor aeration, rocky subsoil, and are nutrient deficient (as determined by underlying bedrock).
- Organic soils are poorly drained, have a low cation exchange, and are infertile (deficient in NPK).
- Soils above granite or diorite bedrock have a high silica content and are phosphate deficient, but because they contain feldspar are high in potassium (K).
- Shale and sandstone derived soils are also high in potassium and low in phosphorus.
- Soils derived from basalt are some of the richest soils found in the Piedmont. A dusky red color is a good indicator of rich soil.

Visual Clues on When to Fertilize

- Look up at your trees. Trees that exhibit a flat crown top, a sparse crown (low leaf area) and yellowing foliage lack some needed nutrient. The more sky you see through the tree's crown, the greater the need for fertilization, and the greater the response will be.

Fertilizing Like the Professionals Do

1) Soil nutrient tests tell us what nutrients are immediately available to a stand of trees, but they do not measure how much nutrient a tree needs. The exception is phosphorus deficiency, which can be identified from soil tests. A soil test with a P index value of less than 3-5 ppm indicates phosphorus deficiency.

2) Foliar analysis provides the best information on what nutrients the tree is able to use from the soil. Foliage samples must be collected in the winter from the last foliage flush in the top third of the crown. This usually requires the use of a pole pruner, a shotgun, or a rifle to collect samples. Values less than those shown in Table 1 indicate a nutrient deficiency.

Table 1. Critical values for foliar and soil nutrient content for loblolly pine. (Expressed as % unless noted)

	N	P	K	Ca	Mg	S	B	Cu
Foliar*	1.2	0.12	0.35	0.12	0.07	0.12	4-8 ppm	2-3 ppm
Soil (0-6 in.)*		<3-5 ppm	<15 ppm					

* Contact the N.C. Cooperative Extension Service or N.C. Division of Forest Resources for information on soil and foliar sampling of forest trees. The N.C. Dept. of Agriculture & Consumer Services analyzes soil and foliar samples at no charge or for a nominal fee.

When Fertilizer Pays the Biggest Dividend

- High quality sites (high site index) produce the greatest volume response.
- High quality Coastal Plain sites respond better than comparable Piedmont sites.
- Poor quality sites (low site index) respond only when nutrient deficiencies are limiting growth.
- Growth is greatest at lower basal areas (fewer trees) where the trees have room to grow and have sufficient foliage to use the added nutrients. Overcrowded stands do not respond well.
- Maximize growth by maintaining stand density at 90-140 square feet of basal area (BA).
- Do not fertilize stands with basal area greater than 130 (increased risk of bark beetle infestation) unless a thinning is planned within three years or a harvest within five years.
- P- deficient soils respond to fertilization with a long-lived and dramatic volume gain that extends into the second rotation.

Thinning and Fertilization

- Fertilization in conjunction with thinning is a beneficial mid rotation practice. Because the growth response is additive, thin and then fertilize within two years.
- To realize the volume growth benefits of fertilization, do not thin or harvest within six years of fertilizing.
- Thin dense stands - basal area greater than 130 - prior to fertilization.
- Leave the best trees. The extra growth on the largest and best trees produces more wood in the highest value products (chip -n-saw, sawtimber, pole).

The Payoff

Volume gains vary and are hard to predict, but….

- Growth gains of 50 - 100 cubic feet per acre per year during a six-year period are possible depending on your soil.
- More than 85 percent of research sites installed by N.C. State University Forest Nutrition Cooperative exhibited significant growth after N+P fertilization.
- Potassium (K) deficient sites averaged less than 40 cubic feet/acre with N + P fertilization but increased to 75 cubic feet/acre/year when K was applied.

How Much and When to Apply

- Apply 150 to 200 pounds per acre of N plus 25 pounds per acre of P for most sites.
- On K or Boron deficient sites, add 30 pounds of K and 1.5 pounds of B for each 100 pounds of N applied.
- The growth response is better when you combine N + P. Do not apply separately.
- DAP (18-46-0) and Urea (46-0-0) are the more commonly applied fertilizers in forest stands.
- The best time to apply is from November to early March.
- Reapply every six to eight years to maintain the best growth response.
- To protect water quality and comply with the state's mandatory Forest Practices Guidelines, keep fertilizers out of streams, ponds, lakes, and ditches and maintain adequate vegetative buffers.

For the best advice on fertilization, Forest Practice Guidelines, and other management decisions on your forestland, consult with a professional forester, or call your local N.C. Cooperative Extension or N.C. Division of Forest Resources office.

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